Thermal radiation in photonic crystals

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We analyze the properties of the thermal radiation in photonic crystals and show that the spectral energy density, the spectral intensity, and the spectral hemispherical power are only limited by the total number of available photonic states and their propagation characteristics. We show that the central quantity that determines the thermal radiation characteristics such as intensity and emissive power is the area of the iso-frequency surfaces. Through the presence of partial or full photonic band gaps and the associated spectral and angular redistribution of photonic states, it is possible to have spectral regions over which the thermal radiation intensity is enhanced relative to the free-space blackbody limit and propagation directions along which thermal photon focusing effects appear.

We also show that the thermal flux has to be compounded with an additional factor of the group velocity such that the standard interpretation of thermal radiation characteristics in photonic crystals – and other strongly scattering systems – via the photonic density of states becomes questionable. In the case of finite photonic crystals, the reflection at the interface between photonic crystal and free space reduces the thermal flux in a manner consistent with Kirchhoff law's.